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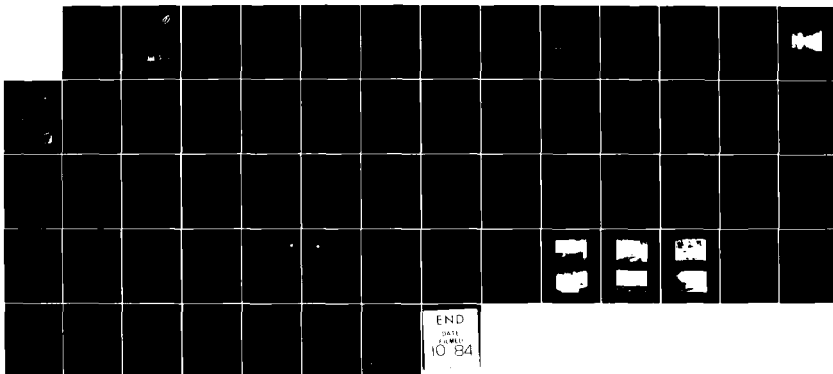
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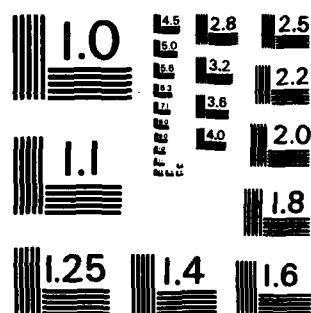
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FRENCH RIVER BASIN,
DUDLEY, MASSACHUSETTS.

LARNER POND DAM
(MA 00111),

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST, 1978

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, French River Basin Dudley, Massachusetts		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Larner Pond Dam is a dry-stone masonry and earth dam. The dam has a maximum height of about 17 feet and is approximately 405 feet long. The dam is considered to be in fair to poor condition. It has been classified in the "high" hazard category. Based on size and hazard classification, the test flood is one-half the PMF.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED-E

JUN 29 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts

Dear Governor King:

I am forwarding for your use a copy of the Larner Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment which emphasizes the inadequacy of the project spillway under test flood conditions is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Larner Pond Dam would likely be exceeded by floods greater than 9 percent of one half the Probable Maximum Flood (1/2 PMF), the test flood for spillway adequacy. Screening criteria for initial review of spillway adequacy specifies that this class of dam, having insufficient spillway capacity to discharge the 1/2 PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations there appears to be a serious deficiency in spillway capacity. This could render the dam unsafe in the event of a severe storm which would likely cause overtopping and possible failure of the dam, significantly increasing the hazard potential for loss of life downstream from the dam.

NEDED-E

Honorable Edward J. King

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.


I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. This report has also been furnished to the owner of the project, Stevens Linen Company, P.O. Box 220, Webster, Massachusetts 01570.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for the cooperation extended in carrying out this program.

Sincerely yours,


JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

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LARNER POND DAM

MA 00111

FRENCH RIVER BASIN
DUDLEY, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00111

Name of Dam: Larner Pond

Town: Dudley

County and State: Worcester County, Massachusetts

Stream: Tributary of French River

Date of Inspection: June 26, 1978

Larner Pond Dam is a dry-stone masonry and earth dam which was constructed about 1830. The dam has a maximum height of about 17 feet and is approximately 405 feet long. It is comprised of an earth dike section approximately 160 feet long by 5 feet high on the east, and a dry-stone masonry and earth dam section 245 feet long 17 feet high on the west. Near the east end of the main dam is a stone masonry spillway with concrete apron approximately 38 feet long. Discharge flows down a stepped stone cascade into a natural earth channel. There are no plans, specifications, or computations available from the Owner, County, or State offices regarding the design, construction, or repairs of this dam.

Due to its age, Larner Pond Dam was neither designed nor constructed by current approved state-of-the-art procedures. Based upon the visual inspection at the site, the lack of engineering data available, and the lack of proper maintenance there are areas of concern which must be corrected to assure the continued performance of this dam. Generally the dam is considered to be in fair to poor condition. Larner Pond has been classified in the "high" hazard category.

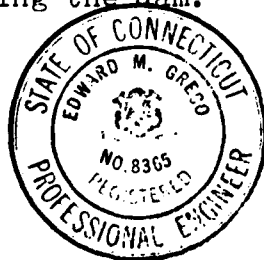
The areas of concern which indicate a potential hazard at the site include: seepage along the downstream toe of both the masonry wall of the dam and the dike, the loss of earthfill along the crest of the dam in various locations, a large depression on the crest

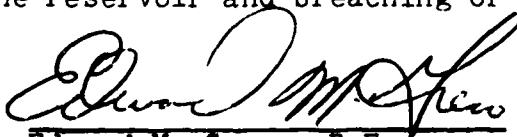
of the dam, large trees and brush growing on the dam, a deteriorated spillway, and uncontrolled flow under the spillway apron slab.

Hydraulic analyses indicate that the dam has insufficient freeboard not only for the inflow test flood but also for the 100-year storm. Based on size and hazard classifications in accordance with Corps guidelines, the test flood is one-half the probable maximum flood. The inflow test flood of 2,580 cfs adjusted for surcharge storage will result in 725 cfs flow through the spillway while flow over the dam crest is predicted to be 1,600 cfs at a depth of almost 2 feet. The spillway is inadequate since it can discharge only 9 percent of the test flood before the dam is overtopped. Overtopping would cause erosion along the dam crest and could cause failure of the dam.

It is recommended that the Owner employ a qualified consultant to investigate the seepage conditions, loss of fill and depression along the dam crest, and to conduct a more detailed hydrologic and hydraulic investigation.

The above recommendations should be implemented within a period of 1 year after receipt of the Phase I Inspection Report. An alternative to these recommendations would be draining the reservoir and breaching or removing the dam.




Edward M. Greco, P.E.

Project Manager
Metcalf & Eddy, Inc.

Connecticut Registration
No. 08365

Approved by:


Stephen L. Bishop, P.E.

Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703



This Phase I Inspection Report on Larner Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

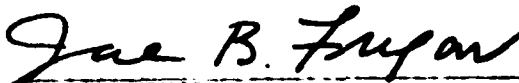


FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division



SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

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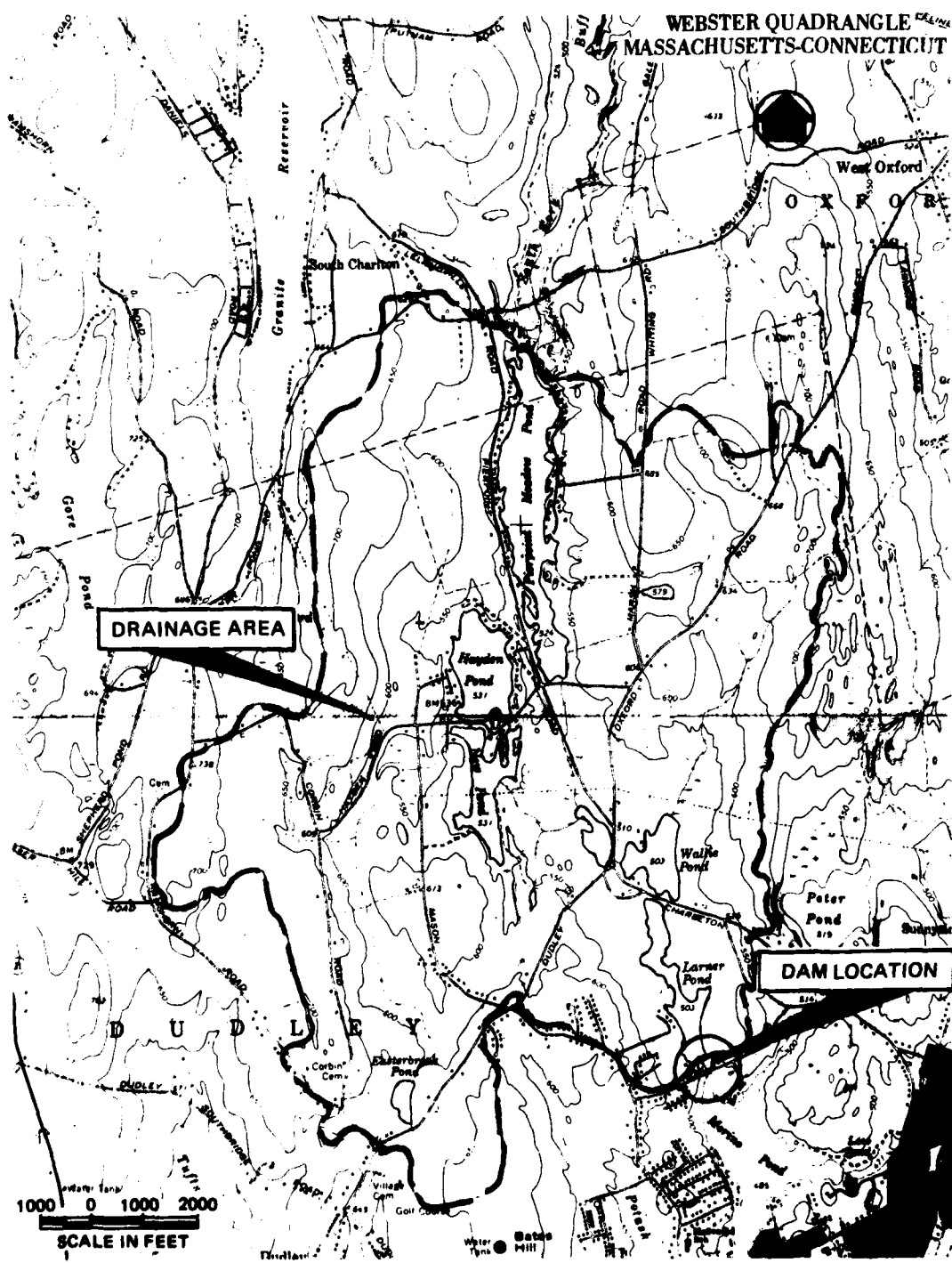
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**OVERVIEW
LARNER POND DAM
DUDLEY, MASSACHUSETTS**



VIEW OF UPSTREAM FACE OF DAM



LOCATION MAP - LARNER POND DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

LARNER POND

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of May 3, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.
- b. Purpose:
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
 - (3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location. The dam is located in the Town of Dudley, Worcester County, Massachusetts, on an unnamed tributary of the French River.
- b. Description of Dam and Appurtenances. Larner Pond Dam consists of a dry-stone masonry and earthfill dam section approximately 245 feet long and 17 feet high, and an earth dike section approximately 160 feet long and 5 feet high (see Appendix B, Figure B-1). The crest of the main dam is about 25 feet wide. The upstream and downstream slopes of the dam are vertical dry-stone masonry walls. The stones placed on the upstream wall are known to extend at least 10 feet deep (depth probed). The downstream wall was measured to be about 16 feet high. The main dam is relatively straight with minor surface irregularities along its crest, with the exception of a 7-foot diameter by 2-foot deep depression on the dam crest.

The dike embankment extends from the east end of the main dam at approximately a 45 degree angle upstream to the axis of the main dam. The width of the dike is approximately 8 feet at the crest. Upstream, the dike consists of a low stone masonry wall. The downstream earth dike slope is about 1 horizontal to 1 vertical.

The spillway is located on the dam about 150 feet east of the right dam abutment. The crest is a slightly sloped concrete apron (maximum El 503) placed over stone blocks and bounded by 2-foot wide mortared stone masonry training walls. The spillway crest is 37.5 feet long at the upstream end and 38.7 feet long at the downstream end. The downstream wall at the spillway consists of large (4.5-foot long) stone masonry steps descending to stream bottom approximately 14 feet from the crest. As shown in Appendix B, Figure B-1, the cascade section of the spillway extends an additional 45 feet east of the spillway. Below the cascade the spillway discharges into

the natural stream channel, which flows through a culvert under Sawmill Road about 250 feet downstream.

The only apparent outlet structure for the dam is a stone masonry conduit about 2 feet by 2 feet situated approximately 65 feet west of the centerline of the spillway. A vertical valve shaft is located in a locked metal box on the upstream face of the dam above the inlet. According to the Owner, the box contains hydraulic jacks which are used to raise and lower the gate, controlling the outlet flow.

- c. Size Classification. Larner Pond Dam is classified as "small" since it has a maximum height of 17 feet and a maximum storage capacity of 240 acre-feet.
- d. Hazard Classification. There are about 10 homes situated off Sawmill Road immediately downstream from the dam. Should the dam fail, the resulting flood wave could cause damage to property and some loss of life in the immediate area. In addition, the Town of Webster is located about one mile downstream. A flood wave due to failure at Larner Pond Dam could cause overtopping and possible failure of both additional downstream dams between Larner Pond and the Town of Webster. If this occurs, there would be considerable damage and possible loss of life in the Town of Webster. Accordingly, the dam is placed in a "high" hazard category.
- e. Ownership. The dam is presently owned by the Stevens Linen Company, P.O. Box 220, Webster, Massachusetts. Mr. Robert Javery of Stevens Linen (617-943-0600) granted permission to enter the property and inspect the dam.
- f. Operator. The Stevens Linen Company has the key for the gate valve box and are the only operators of the dam.
- g. Purpose of the Dam. Larner Pond, also known as Larned Pond, was originally used as a storage dam for a saw and grist mill located downstream. The mill is no longer there. Subsequently, the dam became the property of

the Stevens Linen Company. Water from the pond along with water from two lower ponds is currently used for various operations in the textile factory. Residents in the area also use the pond for recreation.

- h. Design and Construction History. The dam was originally constructed in 1830. There are no plans, specifications, or computations available from the Owner, County, or State offices relative to the design, construction, or repairs of this dam. Previous inspection reports at the Worcester County Commissioner's office indicate that the original timber spillway crest was rebuilt with concrete and stone in 1937. Subsequent inspection reports note seepage in several areas of the dam, but make no mention of repairs. It appears from one report that the "flume was blocked and abandoned" prior to 1942 but was still leaking. According to the Owner, however, the present outlet gate is operational and used to supply water to the lower ponds.
- 1. Normal Operational Procedure. The Owner states that the gate outlet conduit is opened every spring, and periodically when water is needed in the downstream ponds.

The spillway at the dam is ungated and flows over the crest are unrestricted. At the time of the inspection the pond level was 0.6 feet below the assumed benchmark (EL. 503) on the spillway crest. However, water was observed flowing beneath the spillway apron into the stone blocks that comprise the cascade.

1.3 Pertinent Data

- a. Drainage Area. The drainage area above Larner Pond dam is approximately 3,000 acres (4.7 square miles) of gently rolling wood and farmland, and limited residential development along seven residential roads. Wallis Pond and an unnamed pond west of Wallis are at the same elevation as Larner Pond, and are separated from Larner Pond only by two road culverts. These two ponds, plus New Pond,

Hayden Pond, and Pierpont Meadow Pond account for 226 acres, or 7.5 percent of the total drainage area.

- b. Discharge at the Dam Site. Water above El 503 would normally flow over the concrete apron on the spillway, down the cascade, and into a natural stream channel which has a streambed elevation of 488.2. The discharge flows approximately 250 feet south to a culvert under Sawmill Road, and into Merino Pond.

The spillway can discharge an estimated 200 cfs at El 504.4 which is the dam crest. An inflow test flood of 2,580 cfs (one half the probable maximum flood), adjusted for surcharge storage results in a maximum discharge of 2,325 cfs. This outfall will overtop the main dam by 1.9 feet. The maximum flood at the dam site is unknown; however, records at the Worcester County Engineer's Office state that the dam was not overtopped during the 1955 floods.

- c. Elevation (feet above Mean Sea Level). A benchmark elevation of 503 at the spillway crest was estimated from a United States Geological Survey (USGS) topographic map.
- (1) Main dam: 504.4 to 505.8 Dike section: 504.8 to 505.3
 - (2) Test flood pool: 506.3
 - (3) Design surcharge (original design): unknown
 - (4) Full flood control pool: N/A
 - (5) Recreation pool: 503 (spillway crest)
 - (6) Spillway crest (ungated): 503
 - (7) Upstream portal invert diversion tunnel: N/A
 - (8) Stream bed at centerline of dam: 488.2
(Invert of outlet conduit)
 - (9) Tailwater: 489 at outlet structure
488 at spillway

d. Reservoir

- (1) Length of maximum pool: 3,200 feet
- (2) Length of recreation pool: 3,200 feet
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge: 90 at EL 506.3
- (2) Top of dam: 240 (approximate)
- (3) Flood control pool: N/A
- (4) Recreation pool: 200 (approximate)
- (5) Spillway Crest: 200

f. Reservoir Surface (acres) (Assuming that the surface area will not significantly increase with changes in reservoir elevation from 503 to 504.4)

- (1) Top dam: 27
- (2) Test flood pool: 27
- (3) Flood-control pool: N/A
- (4) Recreation pool: 27
- (5) Spillway crest: 27

g. Dam

- (1) Type - Main dam: dry-stone masonry and earthfill
Dike section: earth
- (2) Length - Main dam: 245 feet
Dike section: 160 feet
- (3) Height - Main dam: (maximum) 17 feet
Dike section: 5 feet
- (4) Top width - Main dam: 25 feet
Dike section: 8 feet (varies)

- (5) Side slopes - Main dam: Upstream and downstream vertical walls
Dike section: Upstream: stone masonry wall
Downstream: earth slope 1:1
- (6) Zoning: Unknown
- (7) Impervious core: possibly timber and puddled clay core
- (8) Cutoff: Unknown
- (9) Grout curtain: Unknown

1. Spillway

- (1) Type: Broad crest
- (2) Crest length: 37.5 upstream, 38.7 downstream
- (3) Crest elevation: 503 MSL (assumed benchmark)
- (4) Gates: None
- (5) Upstream Channel: No approach or side walls
- (6) Downstream channel: cascade section: 85-feet wide, eight placed stoneblock steps descend a total of 17.2 feet to channel at natural ground
- (7) General: Spillway channel below cascade flows 250 feet south to culvert under Sawmill Road.

- j. Regulating Outlets. The apparent regulating outlet is a stone masonry conduit which extends from the upstream wall, under the dam to the downstream wall. The outlet has a capacity of 92 cfs (19.6 cfs per square mile). The invert for the conduit outlet is at El 488.2 feet. The gate for the conduit is reportedly operated by means of a hydraulic jack inside a locked metal box. The box overhangs the upstream wall of the dam, and is mounted on I-beams on a concrete frame. Details on the construction of the

gate valve and conduit inside the dam are unknown. Water is discharged at the base of the downstream wall and empties into an overgrown swampy area. A poorly defined outlet channel continues for approximately 50 feet southeasterly where it joins the spillway channel.

SECTION 2
ENGINEERING DATA

- 2.1 General. There are no plans, specifications, or computations available from the Owner, State, or County offices relative to the design, construction, or repairs of this dam. The only data available for this evaluation were visual observations during inspection, review of previous inspection reports, and conversations with the Owner and personnel from the State and County agencies.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole, Joseph Brazauskas, and Mr. Wallace Lindquist - recently retired from county service.

Further assistance was provided by Mr. Robert Javery of the Stevens Linen Company.

- 2.2 Construction Records. There are no detailed construction records available.
- 2.3 Operation Records. No operation records are available, and there is no daily record kept of pool elevation or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. Due to the age of this dam, there is limited engineering data available.
 - b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing

design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

- c. Validity. The limited engineering data available is valid.

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I inspection of the dam at Larner Pond was conducted on June 26, 1978. A copy of the inspection report is included in Appendix A. Periodic inspections of this dam by others have been made since 1925 and a listing of these inspections is in Appendix B. An inspection was made by the Massachusetts Department of Public Works in 1972. A copy of their report is included in Appendix B. In addition, earlier inspection reports were reviewed at the Worcester County Engineer's office.
- b. Dam. The main dam is constructed of dry-stone masonry and earthfill. At the time of the inspection the dam crest was overgrown with grass, shrubs and trees to 36 inches in diameter. A footpath was observed along the crest. A 7-foot diameter by 2-foot deep depression was noted on the downstream side of the crest, just east of the outlet conduit. Also, near the inlet structure, some of the embankment has apparently been washed out behind the upstream wall.

The upstream face of the dam is mostly submerged but appears to be vertical and constructed of stone masonry. The visible upper 1 to 2-foot section shows several capstones missing. The downstream face, also constructed of stone masonry, is vertical and appears relatively sound. Seepage, however, is visible along the downstream wall, from the outlet east to the spillway, extending from 3 to 5 feet high along the wall to the ground. The wall is damp and water was observed at the toe near the spillway.

Midway from the outlet to the west abutment is an earth and stone buttress extending roughly 15 feet off the downstream wall (see Figure B-1, Appendix B).

On the eastern side of the spillway, and along the dike, the upstream stone walls are in fair condition, although some capstones are missing on both the dam and dike section. Downstream the vertical wall ends at the dam/dike transition, and the dike face slopes steeply to a swampy area. Near the transition end there is a small amount of seepage from what could be the remains of an additional outlet structure (roughly a 2-foot wide by 1-foot high sluiceway).

The entire downstream area of the dam and dike is overgrown by shrubs and trees, and is generally wet due to seepage from points along the downstream wall and toe of dike.

- c. Appurtenant Structures. The outlet conduit is probably a stone box conduit. The only part visible was the 2 by 2-foot opening in the downstream wall. Leakage through the outlet at the time of the inspection was estimated at 2 to 5 gpm. The channel below the outlet is poorly defined, and covered with heavy vegetation.

A metal box housing the gate control mechanism is in fair condition. The box was locked but the Owner reports that the gate is in operating condition.

There is no apparent approach apron on the upstream end of the spillway. The only visible structure is a concrete sill submerged about 2 feet below the spillway crest. The 2-1/2-inch concrete apron on the crest is in poor condition - water was observed flowing under the apron and over the stone blocks and could be seen through an approximately 1-foot diameter hole on the crest.

Also at the upstream end a large section of concrete is missing from the northeast corner and the stone blocks are exposed. On the downstream end the concrete apron overhangs the first stone block step on the cascade and is deteriorating.

The training walls on the spillway crest have patches of mortar remaining, and some of the blocks have fallen into the spillway. The walls are no longer continuous. At the southwest end the wall is completely covered by heavy vegetation.

The cascade is in good condition. At the time of the inspection there was no water flowing over the spillway. Water, however, could be heard flowing through the spillway entering the channel below. The stream channel is covered by vegetation.

- d. Reservoir Area. There are few residences on the perimeter of Larner Pond; most of the development is concentrated downstream along Sawmill Road and west along Mason Road. The rest of the drainage area is woodland and farmland with average slope of 1.3 percent. Pierpont Meadow Pond and Hayden Pond on the northern half of the drainage area are moderately developed.
- e. Downstream Channel. Water from the spillway and the outlet conduit flows down the natural stream channel and under a double culvert (two corrugated metal pipes) under Sawmill Road. There are about 10 homes situated off Sawmill Road immediately downstream of the dam. From there the water immediately enters Merino Pond and then into Lower Merino Pond. The Town of Webster is located about one mile downstream of the dam.

- 3.2 Evaluation. The above findings indicate several areas of concern at the dam. In particular, seepage along the downstream wall of the dam; seepage at the toe of the dike; loss of fill material from the crest, and the deteriorated spillway crest require attention.

SECTION 4

OPERATING PROCEDURES

- 4.1 Procedures. According to the Owner, the outlet gate is opened every spring, and periodically when water is required in one of the downstream mill reservoirs.
- 4.2 Maintenance of Dam. The Owner states that the dam is cleared of brush, inspected annually in the spring, and checked after periods of high rain. The overgrowth of vegetation and the number of large trees on the dam indicates that the maintenance program has been inadequate.
- 4.3 Maintenance of Operating Facilities. The box housing the gate valve was recently repaired, and the Owner states that the screw mechanism was at some time replaced by hydraulic jacks. The leakage around the outlet conduit requires attention.
- 4.4 Description of Any Warning System in Effect. There are no warning systems in effect at this dam. The Owner stated that the dam is checked after periods of heavy rainfall.
- 4.5 Evaluation. The program of inspection and repair followed by the Owner should be expanded and made systematic, since this dam is in the "high" hazard category. Although some maintenance has been done, it appears to be limited to minor repairs.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. The Probable Maximum Flood (PMF) was determined to be 1,100 cfs per square mile. This calculation is based on the average drainage area slope of 1.3 percent, the pond-plus-swamp-area to drainage-area ratio of 10.2 percent, as well as the U. S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying one-half the PMF maximum flood rate to the 4.7 square miles of drainage area results in a calculated peak flood flow of 2,580 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 2,325 cfs (495 cfs per square mile), with a water surface at El 506.25.

Flow over the dam crest is computed to be 1,600 cfs, while flow through the spillway section would be 725 cfs. The maximum head on the dam would be 1.9 feet at a discharge of 6.68 cfs per foot of width. A flow having a 1.12-foot depth and a velocity of 6.0 feet per second would occur where flow becomes critical over the dam crest.

Hydraulic analyses indicate that the existing spillway can discharge a flow of 200 cfs at El 504.4, which is the dam crest.

- b. Experience Data. Limited experience records are available for this dam. Conversations with Mr. W. Lindquist indicated that the dam was not overtopped in the 1955 flood.
- c. Visual Observations. The spillway is located on the dam about 150 feet east of the

right dam abutment. The crest is a flat concrete weir placed over stone blocks and bounded by 1.5-foot high training walls. The crest is 37.5 feet long at the upstream end and 38.7 feet long at the downstream end. The width of the crest is 27.8 feet. The spillway discharges into a natural stream channel which flows through a culvert under Sawmill Road about 250 feet away.

- d. Overtopping Potential. Hydraulic analyses indicate that the spillway can discharge only 200 cfs. Overtopping of the dam will not only occur under the inflow test flood but also the 100-year storm flood. The 100-year storm outflow is predicted to be 900 cfs at pond El. 505.4 which is 1 foot above the dam crest.

However, the dam is about 150 years old and has no history of failure and/or overtopping. The dam flood flows are probably attenuated by upstream retention in other ponds and swamps. Future development in the watershed area may increase the present runoff conditions and increase flood flows at the dam site.

Failure of the dam would produce a peak discharge of 5,900 cfs, as estimated using U.S. Corps of Engineers criteria, with a flood wave in the order of 9 feet. This flood would be partially impeded by Sawmill Road, before reaching Merino Pond.

The total pond volume would take about 0.7 hours to drain into Merino Pond and would raise its level about 1.8 feet. The flood wave could damage several residences on Merino Pond, although the effects would be mitigated by Sawmill Road.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of Larner Pond Dam is based on the visual inspection on June 26, 1978. Based on the observations as detailed in Section 3, Visual Inspection, Larner Pond Dam may be a hazard. The condition of the dam is unsatisfactory and conventional factors of safety may not exist.

Seepage, exiting along the downstream face of dam and toe of dike, alone or in combination with loss of material from the crest are major factors contributing to marginal conditions. It is recommended that a more detailed investigation be initiated to evaluate these areas of concern.

- b. Design and Construction Data. Discussions with the Owner, Town, County, and State personnel indicate that there are no plans, specifications, or computations relative to the design, construction, or repairs of this dam. Information on the type, shear strength, and permeability of the soil and/or rock materials of the dam embankment is not available.
- c. Operating Records. There is no evidence of instrumentation of any type in Larner Pond Dam, and there is nothing to indicate that any instrumentation was ever installed in this dam. The performance of this dam under prior loading can only be inferred by previous records and physical evidence at the site.

- d. Post-Construction Changes. There are no as-built drawings for Larner Pond Dam. Review of inspection reports and discussions with County personnel and the Owner indicate that some changes and/or repairs have been made since 1925. These include rebuilding the spillway crest from timber to concrete and stone, and installing hydraulic jacks to operate the outlet gate.
- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Due to its age, Larner Pond Dam was neither designed nor constructed to the current approved state-of-the-art procedures. Based upon the visual inspection at the site, there are areas of concern which must be corrected to assure the continued performance of this dam.

Generally, the dam is considered to be in fair to poor condition. The areas of concern include seepage at the downstream toe of the dam and dike, and loss of fill and a large depression along the dam crest, large trees and brush growing on the dam, a deteriorated spillway, and uncontrolled flow under the spillway apron slab. The large depression on the dam crest may indicate a piping condition along the outlet conduit which should be investigated further. In addition, brush and trees along the dam may cover potentially serious conditions.

Hydraulic analyses indicate the existing spillway can discharge a flow of 200 cfs at El 504.4, which is the dam crest. The spillway is inadequate since it can discharge only 9 percent of the test flood before the dam is overtopped. An inflow test flood of 2,580 (one-half the probable maximum flood) will overtop the main dam by about 1.9 feet. Since previous records at this site indicate the dam at its present elevation was not overtopped in the 1955 flood, it is unlikely that this is a serious hazard. However, it is not known what the pond elevation was prior to the 1955 storm. Possibly the pond was at a seasonal low elevation thereby providing sufficient storage to lessen the effects of the rainfall. Also the pond level may have been intentionally lowered because of the impending storm. Evidently, upstream storage in other ponds and swamps minimizes the possibility of overtopping at this dam. However, future development in the

watershed area could increase the runoff and peak flows and could create a more serious hazard.

- b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.
- c. Urgency. The recommendations outlined below should be implemented within one year after receipt of the Phase I inspection report.
- d. Need for Additional Information. Additional investigations to further assess the adequacy of the dam and appurtenant structures are outlined below in Section 7.2 Recommendations.

7.2 Recommendations. In view of the concerns for the continued performance of this dam, it is recommended that the Owner employ a qualified consultant to:

- a. Evaluate the dam stability particularly the seepage and loss of fill and large depression along the dam crest;
- b. Conduct a more detailed hydrologic and hydraulic investigation for the entire drainage area. The purpose of the investigation is to determine whether a means should be provided for discharging a greater portion of the test flood.

The recommendations for repairs and maintenance procedures are stated below under Section 7.3 Remedial Measures.

7.3 Remedial Measures

- a. Alternatives. An alternative to the recommendations above and repairing the dam and providing proper maintenance and scheduled inspection would be draining the reservoir and breaching or removing the dam.

- b. Operation and Maintenance Procedures. The dam and appurtenances are not adequately maintained. It is recommended that the Owner accomplish the following:
- (1) replace the fill along the dam crest after a detailed investigation as to the cause of the large depression in the crest just west of the spillway,
 - (2) repair the concrete weir and sidewalls on the spillway,
 - (3) remove the brush and large trees from the dam,
 - (4) clear all debris and brush from the channel below the spillway, and from the outlet channel,
 - (5) institute a program for surveillance and a warning system during periods of unusually heavy rains and/or runoff, and
 - (6) implement a systematic program of inspection and maintenance. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances. This should be undertaken in accordance with all applicable State regulations.

APPENDIX A
PERIODIC INSPECTION CHECKLIST

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Larner Pond Dam

DATE 6/26/78

TIME 8:00 am

WEATHER warm and sunny

W.S. ELEV. 502.4 U.S. 488.3 D.N.S.

Assumed benchmark elevation 503
at spillway crest

PARTY:

1. Richard Weber

6. M. Pacillo

2. Lyle Branagan

7. _____

3. Ed Greco

8. _____

4. Carol Sweet

9. _____

5. Susan Pierce

10. _____

PROJECT FEATURE

INSPECTED BY

REMARKS

1. Dam

Richard Weber

2. Spillway

Lyle Branagan

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond DATE 6/26/78
 PROJECT FEATURE Dam NAME R. Weber
 DISCIPLINE Geotechnical NAME E. Greco

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	varies from 504.0 to 505.8
Current Pool Elevation	502.4
Maximum Impoundment to Date	unknown
Surface Cracks	depression on crest 7x7 ft x 2 ft deep
Pavement Condition	n/a
Movement or Settlement of Crest	surface irregular
Lateral Movement	none visible
Vertical Alignment	downstream (and upstream?) walls vertical
Horizontal Alignment	relatively straight
Condition at Abutment and at Concrete Structures	right abutment natural ground left abutment transition to dike
Indications of Movement of Structural Items on Slopes	upstream wall right of spillway: capstones dislodged and missing; erosion on u/s face; washout behind u/s outlet head wall
Trespassing on Slopes	small trees; footpath along crest
Sloughing or Erosion of Slopes or Abutments	erosion of upstream face near right spill way training wall
Rock Slope Protection - Riprap Failures	no riprap
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	swampy area along d/s toe seepage visible only at outlet
Piping or Boils	none visible
Foundation Drainage Features	unknown
Toe Drains	unknown
Instrumentation System	none visible

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond DATE 6/26/78
 PROJECT FEATURE Dike NAME R. Weber
 DISCIPLINE Geotechnical NAME E. Greco

AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	
Crest Elevation	varies from 504.8 to 505.3
Current Pool Elevation	502.4
Maximum Impoundment to Date	unknown
Surface Cracks	none visible
Pavement Condition	n/a
Movement or Settlement of Crest	crest surface irregular
Lateral Movement	none visible
Vertical Alignment	irregular crest
Horizontal Alignment	dike crest is "S"-shaped from main dam to left dike abutment
Condition at Abutment and at Concrete Structures	abutment ties into natural ground
Indications of Movement of Structural Items on Slopes	none visible
Trespassing on Slopes	large trees (36", 12") and brush; footpath; pipe tying into pond
Sloughing or Erosion of Slopes or Abutments	upstream slope near dam abutment missing some capstones
Rock Slope Protection - Riprap Failures	stones placed irregularly on upstream slope
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	swampy, moist, as evidenced by vegetation; standing water at d/s toe.
Piping or Boils	none visible
Foundation Drainage Features	unknown
Toe Drains	unknown
Instrumentation System	unknown

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond DATE 6/26/78
 PROJECT FEATURE Intake NAME L. Branagan
 DISCIPLINE Geotechnical - Hydraulic NAME E. Greco

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	not visible
Slope Conditions	" "
Bottom Conditions	" "
Rock Slides or Falls	" "
Log Boom	" "
Debris	" "
Condition of Concrete Lining	" "
Drains or Weep Holes	" "
b. Intake Structure	" "
Condition of Concrete	" "
Stop Logs and Slots	" "

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond DATE 6/26/78
 PROJECT FEATURE outlet NAME L. Branagan
 DISCIPLINE Geotechnical - Hydraulic NAME E. Greco

AREA EVALUATED	CONDITION
* <u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	2 x 2 ft opening in stone masonry
Rust or Staining on Concrete	n/a
Spalling	"
Erosion or Cavitation	"
Cracking	"
Alignment of Monoliths	roughly regular
Alignment of Joints	n/a
Numbering of Monoliths	"

* Outlet control is vertical valve shaft which enters locked box above water level. Box is reported to contain hydraulic jacks to lift and lower valve.

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond DATE 6/26/78
 PROJECT FEATURE Outlet NAME R. Weber
 DISCIPLINE Geotechnical NAME E. Greco

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	headwall d/s side unmortared stone masonry
Rust or Staining	n/a
Spalling	"
Erosion or Cavitation	"
Visible Reinforcing	"
Any Seepage or Efflorescence	seepage 5 ft west of outlet leakage at outlet, estimated 2-5 gpm*
Condition at Joints	joints open; condition fair to good
Drain Holes	none visible
Channel	small pool, few stones
Loose Rock or Trees Overhanging Channel	trees to 12-inch diameter
Condition of Discharge Channel	poor -- cluttered with brush and debris

* slight seepage 10 feet east of spillway. Also, general area of seepage along headwall from just east of outlet to spillway, 3 to 5 feet high along wall.

Flow from outlet conduit travels southeast approximately 50 feet to join flow from spillway.

PERIODIC INSPECTION CHECK LIST

PROJECT Larner Pond

DATE 6/26/78

PROJECT FEATURE Spillway

NAME L. Branagan

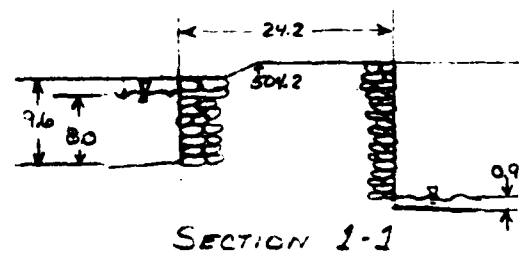
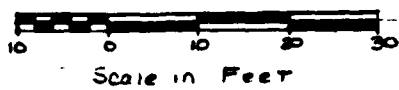
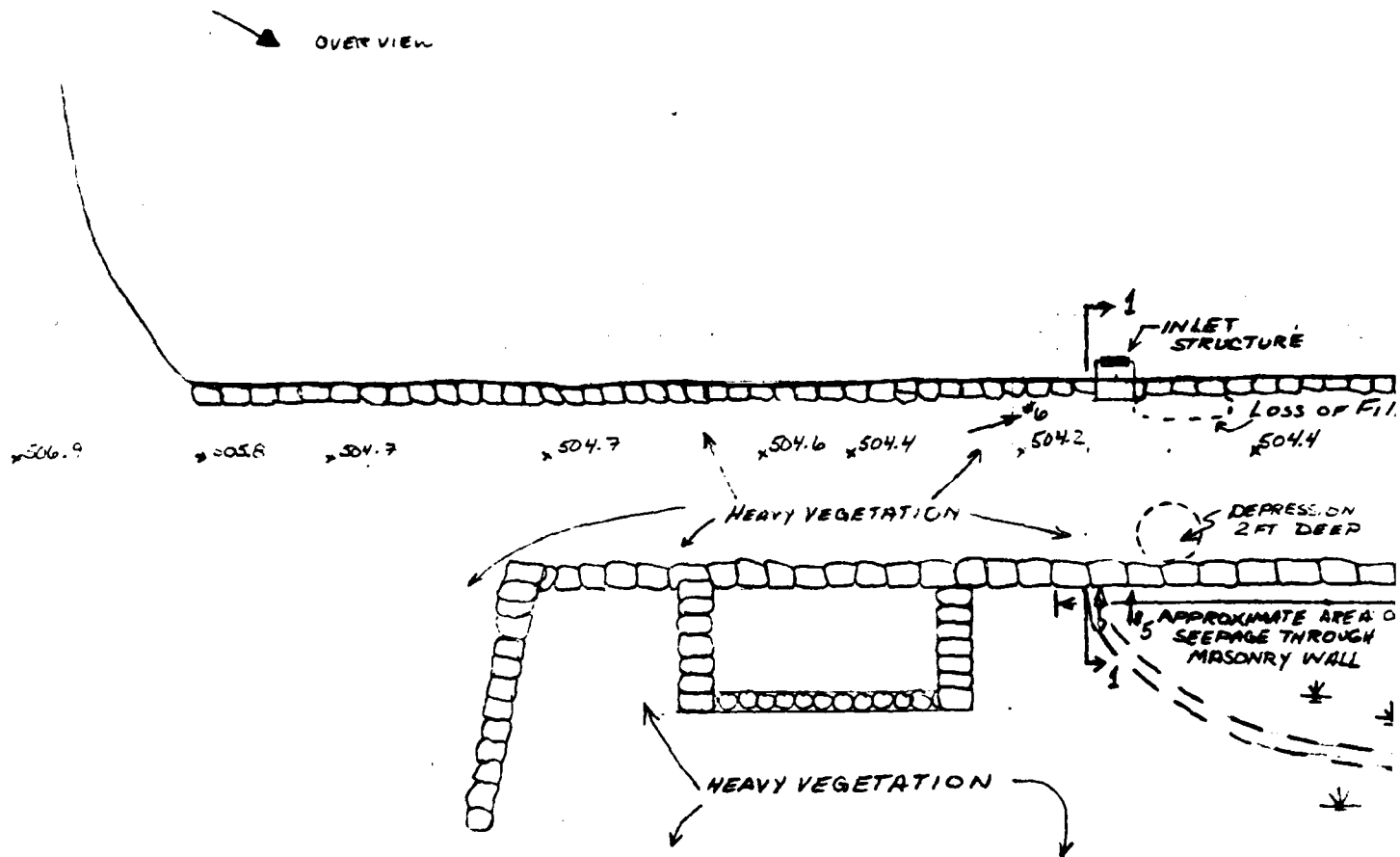
DISCIPLINE Hydraulics

NAME E. Greco

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	none
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	2 1/2 - inch concrete cap over stone masonry
General Condition of Concrete	poor - concrete missing on east corner, u/s; hole approx 1-ft dia. on crest
Rust or Staining	n/a
Spalling	rock walls dislodged
Any Visible Reinforcing	yes, on northeast corner of spillway
Any Seepage or Efflorescence	seepage and flow below concrete cap
Drain Holes	none visible
c. 1) Discharge Channel	stone masonry cascade
General Condition	good
Loose Rock Overhanging Channel	n/a
Trees Overhanging Channel	none to hinder flow
Floor of Channel	stepped stone downstream face of dam
Other Obstructions	minor stone and wood on cascade
2) Discharge channel	natural stream
General condition	overgrown with vegetation

APPENDIX B
PLAN OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1. Plan of Dam, and Sections	B-1
Previous Inspections (Partial Listing)	B-2
Inspection Report by Mass. Department of Public Works, January, 1972	B-3



METCALF & EDDY, INC.



LARNER POND

WS Elev. 502.4

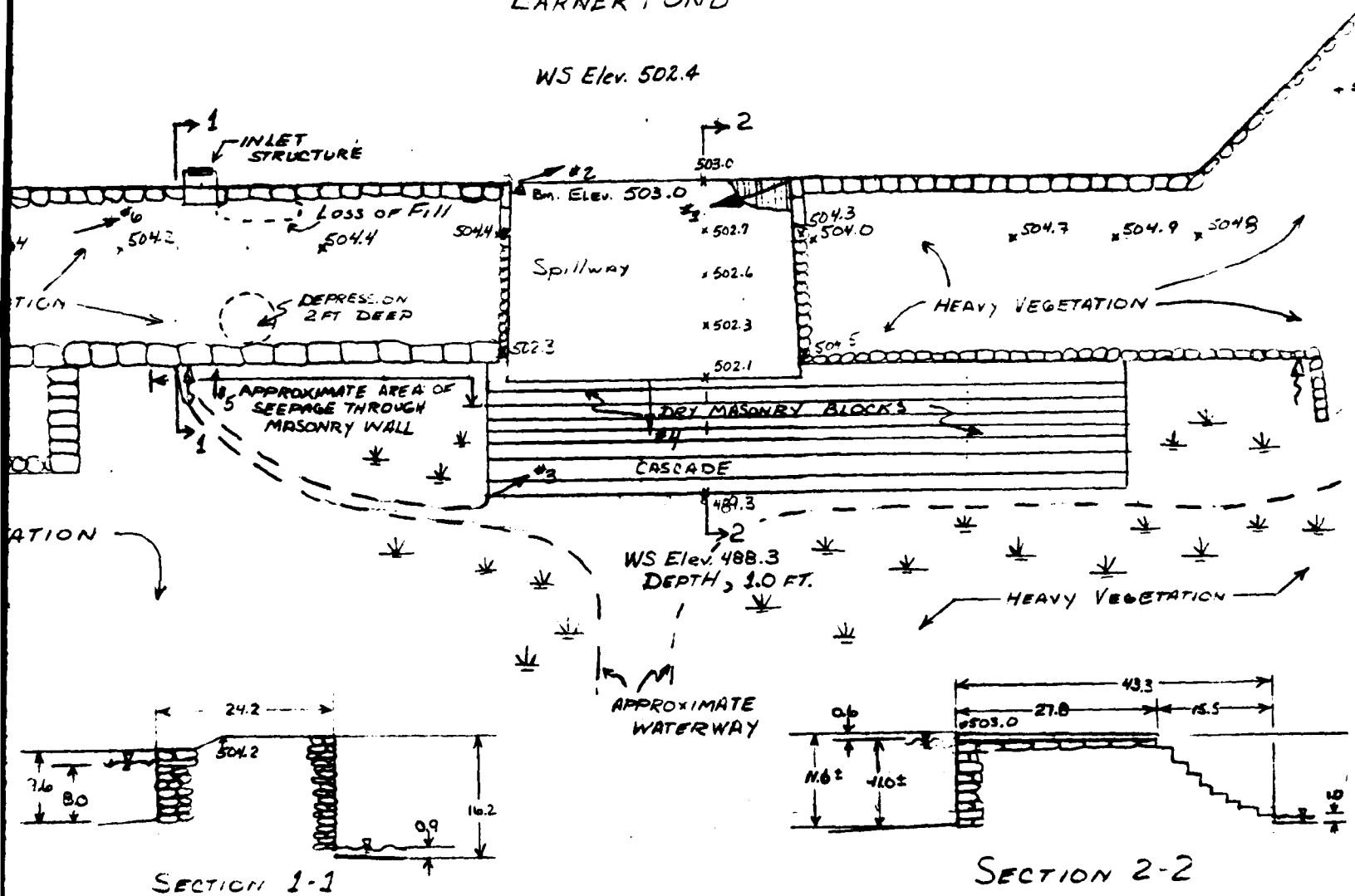


FIGURE B-1

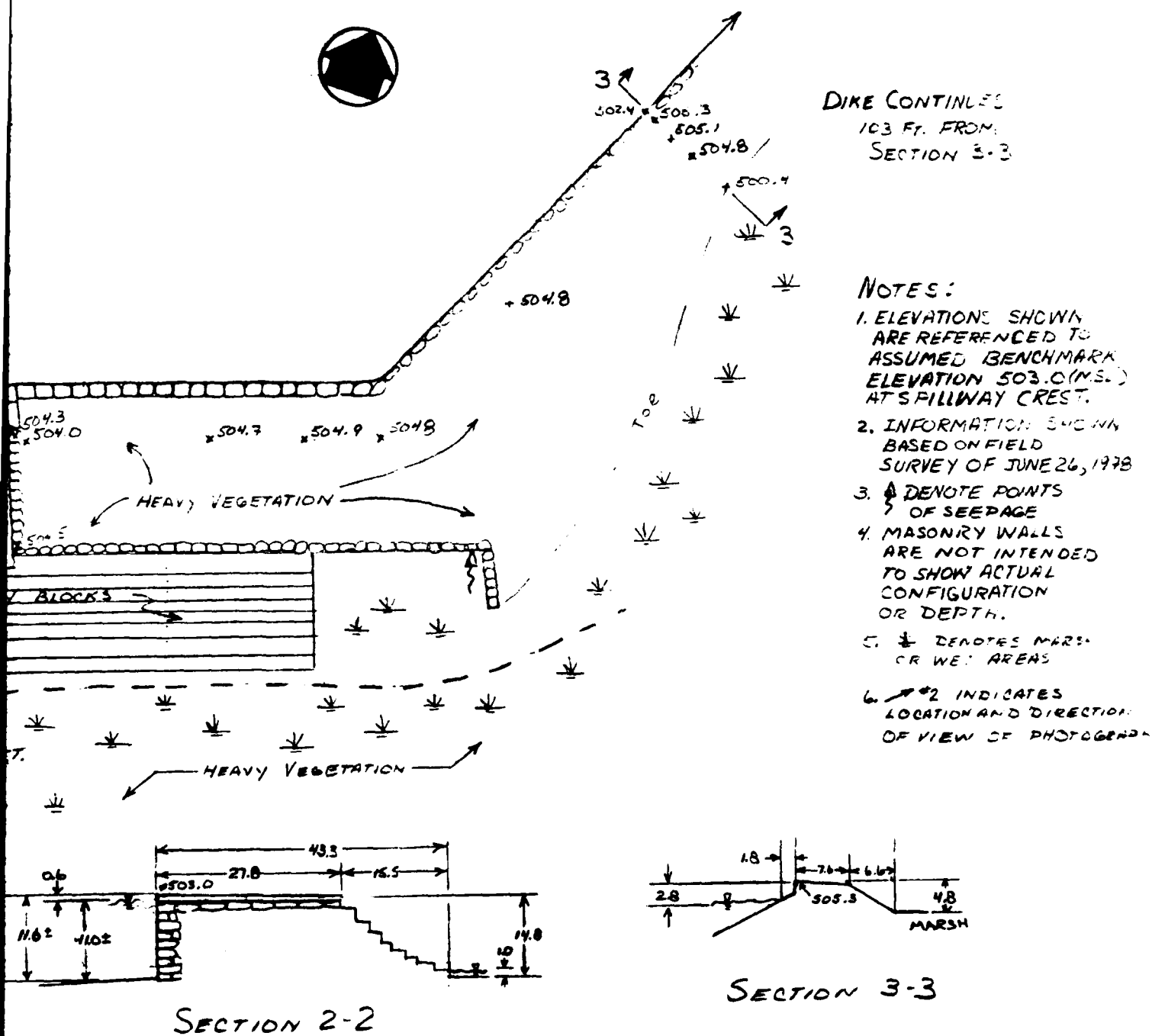


FIGURE B-1 PLAN OF DAMS AND SECTION 2

(H)

INSPECTION REPORT & DATA FOR DAMS

Owner: STEVENS LINEN ASSOCIATES
His Address: MILL ST DUDLEY
Function of Dam: STORAGE POND

Dam No. 14-08
Town: DUDLEY
Stream: BROOK
Pond: LARNER POND
Date: 1/10/72
By: _____

Location & Access: SAW MILL POND RD, LARNER POND

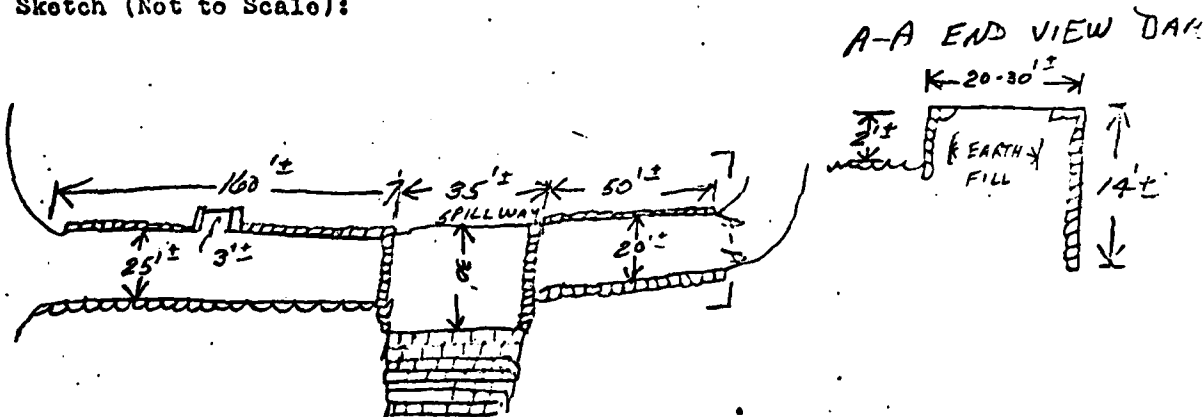
CONDITION RATING
Structural: FAIR
Hydraulic: 3.5 X 1.5
General: FAIR
PRIORITY: NONE

USGS Quad. Webster Lat. 42°03'18" Long. 71°54'15"
Drain. Ar.: 339 Sq. Mi. Ponds: no. Res. Dam: no.
Character of D.A.: _____

Estimated
Discharge: _____
Capacity: _____

General Description of Dam and Discharge Control:

STONE MASONRY WALLS W/ EARTH FILL
3 GATE OPEN CANNOT SEE ANY BOARDS, WATER 1'±
BELOW GOING OVER SPILLWAY. SPILLWAY WALLS 18" ABOVE
SPILLWAY.
Sketch (Not to Scale):



Remarks and Recommendations:

STONE MASONRY WALLS FACING THE WATER HAVE
BEEN REMOVED IN NUMEROUS SPOTS CAUSING
DEPRESSIONS IN DAM FACE FROM 1'-2'± IN SPOTS,
NO APPARENT DANGER.

Date

1/10/72

By

VFP
RTI

Comment

Dam No. 14-08

APPENDIX C
PHOTOGRAPHS



NO. 1 - VIEW LOOKING WEST FROM SPILLWAY



NO. 2 - VIEW LOOKING EAST FROM SPILLWAY



NO. 3 - VIEW EAST OF CASCADE SECTION OF SPILLWAY



**NO. 4 - VIEW OF DOWNSTREAM CHANNEL
FROM EDGE OF SPILLWAY**



NO. 5 - VIEW OF DOWNSTREAM DAM FACE 40 FOOT WEST OF SPILLWAY



NO. 6 - VIEW OF CONTROL MECHANISM FOR OUTLET CONDUIT

APPENDIX D
HYDROLOGIC AND
HYDRAULIC COMPUTATIONS

Project NAT. REVIEW OF NONFED. DAMS Acct No. 5864 Page 1 of 6
 Subject WORCESTER MASS. AREA Compld By LEB Date 7/7/78
 Detail LARNER POND Ckd By REP Date 7/11/78
 Rev. 7/19/78 LEB

(I) DETERMINE PEAK RUNOFF TO POND

Est Slope: $\frac{710' - 503'}{7.7' (2000' / 100')} = 1.34\%$

Pond & Swamp Areas:

Larner Pd -	0.04 mi ²	} Same Surface Elev. Separated by Roads & Culverts
Wallis Pd -	0.04 "	
Unnamed Pd -	0.01 "	
New Pd -	0.05 "	
Hayden Pd -	0.07 "	
Pier. Hdr. Pd -	0.14 "	
	<u>0.35 mi²</u>	
Swamps (by eye)	0.03 mi ²	
	0.04 "	
	0.06 "	
	<u>0.13 mi²</u>	

Total Area Ponds & Swamps = 0.48 mi²

Total Drainage Area = 4.69 mi²

\therefore D.A. is 10.2% Ponds & Swamps

Using M.P.F. - Peak Flow Rate Chart - Larner Pond appears to be between "Leesville Dam" and "Flat & Coastal"

Approx Ratio - $\frac{1.34\% - 0.6\%}{3.0\% - 0.6\%} = 31\%$ of Vert Dist - Use 50%

Say 1100 cfs / mi²

M.P.F. = 1100 x 4.69 = 5159 cfs.

$\frac{1}{2}$ M.P.F. = 2580 cfs. = Inflow Test Flood

100 yr storm

For Ave Low Infiltr. Rate of 0.18 in./hr. (50% B & 50% C Soils)

Using 6 hour rainfall values, total infiltration = 1.1"

Total 6 hour rainfall for Std. 6 hr. storm = 4.7"

$\therefore Q_{100} = 5159 \left[\frac{4.7 - 1.1}{19.0 - 1.1} \right] = 1040 \text{ cfs.}$

Storage Functions:

Inflow Test Flood: $Q_{F_T} = 2580 \left(1 - \frac{S_F}{9.5} \right) = 2580 - 272 S = F_T$

Q_{100} Inflow: $Q_{F_{100}} = 1040 \left(1 - \frac{S_F}{4.7} \right) = 1040 - 221 S = F_{100}$

Project NAT. REVIEW OF NONFED DAMS Acct No. 5864 Page 7 of 6
 Subject WORCESTER MASS FIRE Comptd. By LEB Date 7/7/78
 Detail LARNER POND DAM Ckd. By RPW Date 7/11/78
 Rev. 7/19/78 LEB

II Storage vs Pond Elev.

Larner, Wallis & Unnamed Ponds all interconnected and have same elevations. Incl. adjacent swamps

At Elev. 503 - Water Area = 0.09 mi²
 At Elev. 510 - Area = 0.19 mi²

Elev.	Area	Storage Incr. (in-mi ²)	Σ Stor. Incr. (in-mi ²)	S' (in-m D.A.)	Storage Function Inf. Test Flood	Storage Q
503	0.09		0	0	2580	1040
504	0.10	1.14	1.14	0.24		
505	0.12	1.32	2.46	0.52		925
506	0.13	1.50	3.96	0.84	2352	854
507	0.15	1.69	5.65	1.20	2253	775
508	0.16	1.86	7.51	1.60	2145	
509	0.18	2.04	9.55	2.04	2025	
510	0.19	2.22	11.7	2.49	1902	

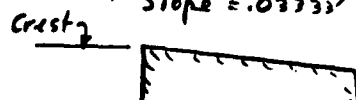
METCALF & EDDY, ENGINEERS

III Discharge @ Dam

(a) Discharge Conduit has minimal value during high flows and is ignored here.

(b) Spillway 37' Wide - assume side contraction at one foot depth = 2(.1)1 = 0.2'. For higher depths flow can approach crest across training walls. Contraction will be reduced. Use net weir width = 36.8'

Spillway is 27' long below crest. & drops 0.9 feet.
 Slope = 0.0333



Compare Spillway Capacity w/ Critical Flow
 for unit width: $q = \frac{1.49}{1.015} (y)^{3/2} (1.026) = 18.136 y^{3/2}$
 $q_c = (y^3 g)^{1/2}$

y	1	2	3	4
q	18.14	28.8	37.7	45.7
q _c	5.67	16.0	29.5	43.4

Generally $q > q_c$ on spillway
 so do not reduce disch.
 cap. of weir from sharp edge value

Project NAT. REVIEW OF NON FED DAMS Acct. No. 5864 Page 3 of 6
 Subject WORCESTER MASS. AREA Comptd. By LEB Date 7/7/78
 Detail LARNER POND DAM Chkd. By RPV Date 7/11/78

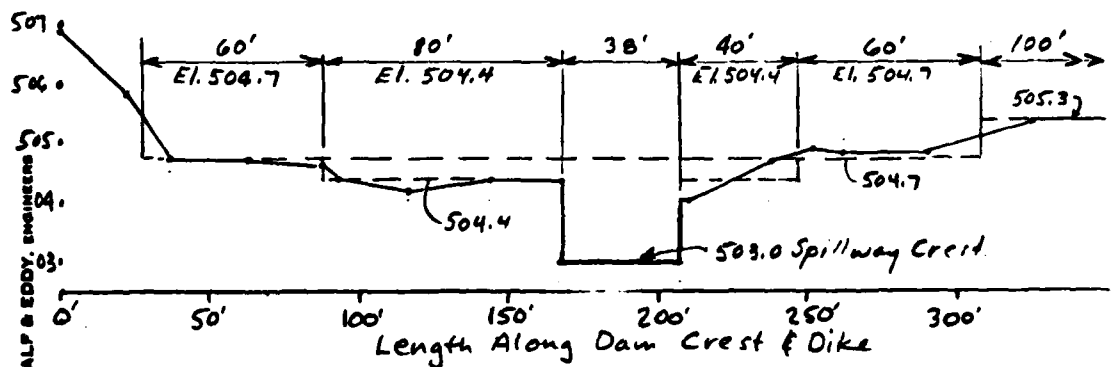
III Disch. @ Dam (Cont.)

[Ref - "Hyd. Tables" - Williams & Hagen]

For $L = 36.8'$, $p = 10'$

Elev.	503.5	504.0	504.5	505.0	506.0	507.0	506.5
h	0.5	1.0	1.5	2.0	3.0	4.0	3.5
Q	45	123	224	347	645	1005	823

(c) Flow Over Crest $q = 2.55(H)^{3/2}$



Disch. /ft over dam crest = $q = 2.55(H)^{3/2}$

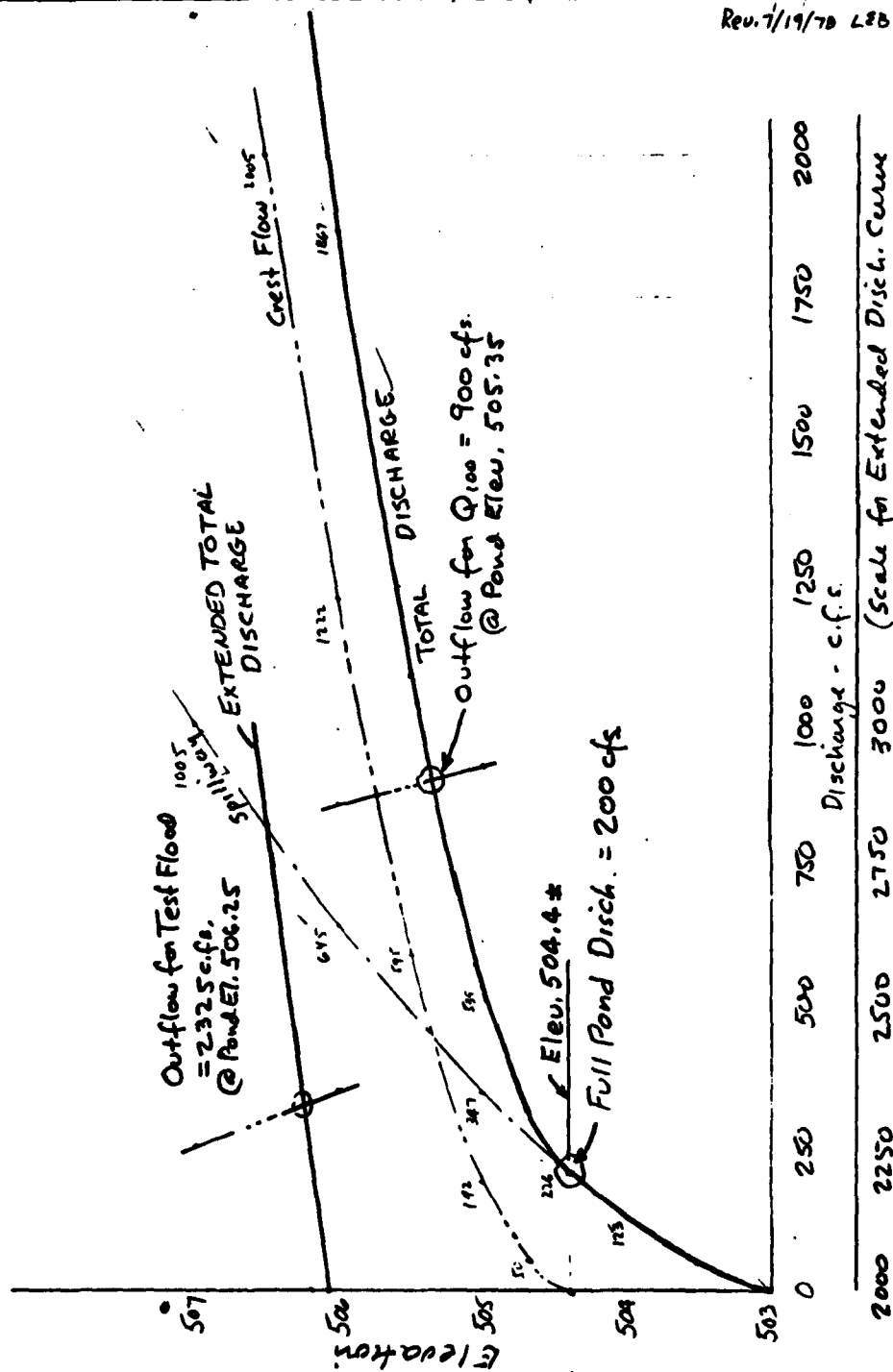
$$Q_1 = 120(2.55)(H - 504.4)^{3/2}; Q_2 = 120(2.55)(H - 504.7)^{3/2}; Q_3 = 100(2.55)(H - 505.3)^{3/2}$$

Elev.	504.7	505.0	505.3	505.5	506.0	506.5	507.0
Q_1	50	142	261	353	619	931	1283
Q_2	—	50	142	219	454	739	1067
Q_3	—	—	—	23	149	335	565
Q_{crest}	50	192	403	595	1222	2005	2915

Project NAT. REVIEW OF NON FED DAMS Acct. No. 5864 Page 4 of 6
 Subject WORCESTER MASS. AREA Compld. By LEB Date 7/11/78
 Detail LARNER POND DAM Ckd. By P.P.W. Date 7/19/78 LEB

Rev. 7/19/78 LEB

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Project NAT. REVIEW OF NON FLD DAMS Acct No. 5864 Page 5 of 6
 Subject WORCESTER MASS AREA Comptd. By LEB Date 7/11/79
 Detail LARNER POND DAM Ch'd. By EMG Date 7/25/79
 Rev. 7/19/78 LEB

IV (A) Maximum Discharge

From Intersection of Discharge Curve with Storage Function:

Test Flood Outflow = 2325 c.f.s. ✓
 with Pond Elev. @ 506.25 ✓

Max Flow on Crest - @ Max Depth of 1.85' - Say 1.9'

$$q = 2.55 (1.9)^{3/2} = 6.68 \text{ cfs/ft.}$$

$$\text{Critical Depth} = \left(\frac{q^2}{g} \right)^{1/3} = 1.115' \quad \checkmark$$

$$\text{Critical Velocity} = 6.0 \text{ fps}$$

(B) 100 yr Storm Discharge

From Intersection of Disch. Curve with Storage Function:

"100yr" storm outflow = 900 cfs ✓
 with Pond @ Elev. 505.35

(C) Full Pond Discharge

From Discharge Curve $Q_{Full} = \underline{200 \text{ cfs.}}$

(D) Sluice Pipe Discharge

$$\text{Say Pipe Entrance Loss} = 0.7 V^2 / 2g$$

$$\text{Flow Head} = 1.0 V^2 / 2g$$

$$\text{Total Loss} = 1.7 V^2 / 2g$$

Ignore Pipe Friction due to short length:

Pond Elev. 503; & Pipe Elev. 489; Initial Head = 14'

$$V_{14} = \left[\frac{64.4 (14)}{1.7} \right]^{1/2} = 23 \text{ fps.}; Q_{14} = 4 (23) = 92 \text{ c.f.s.}$$

Drainage Area: 4.69 mi² ∴ Peak Sluice Disch. = 19.6 c.f.s.

Project NAT. REVIEW OF NON FED DAM Acct. No. 5864 Page 6 of 6
 Subject WORCESTER MASS AREA Comptd. By LEB Date 7/11/78
 Detail LARNER POND Ch'd. By Emc Date 7/22/78

(V) Dam Failure Flows

A - Peak Discharge

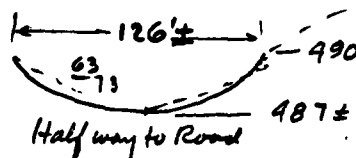
Assume Pond at Elevation 505.5 (1' ± over crest)

Liner Pond Storage: Above Crest - $2.5' \times 0.04 \text{ mi}^2 \times 640 = 64 \text{ ac. ft.}$
 Below Crest - $8' \times \frac{1}{2} \times 0.04 \text{ mi}^2 \times 640 = 102 \text{ "}$

Total @ Failure 166 Ac. ft.

$$Q_1 = \frac{B}{2.7} (0.4 \times 220') \sqrt{g} (9.6 + 2.5')^{3/2} = 6228 \text{ c.f.s.}$$

B - Discharge Valley Rating



Many trees - much brush

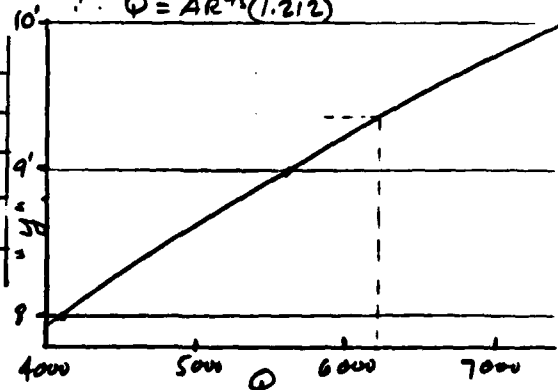
Say $n = 0.15$, $A = 21 y^2$, $P = 42 y$

$Q = A \frac{1.49}{n} R^{2/3} S^{1/2}$, $S \approx \frac{3}{200} = .015$

$\therefore Q = AR^{2/3} (1.212)$

METCALP & EDDY, ENGINEERS

y	4'	6'	8'	10'	9'
A	336	756	1344	2100	1701
P	168	252	336	420	378
$R^{2/3}$	1.587	2.08	2.52	2.92	2.73
Q	646	1906	4105	7442	5619
V			3.05	3.54	3.30



$Q_1 = 6228$, $y = 9.35'$, $A = 1836 \text{ ft}^2$, $\text{Vol.}_1 = 200(1836) = 367200 \text{ cu. ft.}$

$Q_2 = 6228 \left(1 - \frac{8.4}{166}\right) = 5911 \text{ c.f.s.}$

Wave $\approx 9'$

C - Time to Drain

$$\frac{166(43540)}{5911(1/2)(3600)} = \underline{0.7 \text{ hours}}$$

d. Rise in Mariano Pond

$$\frac{166 \text{ Ac. ft.}}{\pm 90 \text{ ft.}} = 1.84'$$

APPENDIX E
INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	COUNTY	DIST	NAME	REPORT DATE
MA	111	NED	LARNER POND DAM	15AUG78

POPULAR NAME	NAME OF IMPROVEMENT
	LARNER POND

RECORD NO.	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01 06	TR-FRENCH RIVER	NESTER	1	14500

TYPE OF DAM	YEAR COMPLETED	PURPOSES	HYDRAULIC HEIGHT (FT.)	IMPROVING CAPACITIES (ACRE-FT.)	DIST URM	FED R	PRV/PED	SCS A	VEN/DATE
RP PGR	1030	SR	10	17	200	NED	N	N	09AUG78

REMARKS

D/S	SPILLWAY	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CU FT.)	POWER CAPACITY (KW)	NAVIGATION LOCKS
1	405 U 30	200	5200		

OWNER	ENGINEERING BY	CONSTRUCTION BY
STEVENS LINEN COMPANY		

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
MTICALP + EDDY, INC	26JUN78	PL 92-367

REMARKS

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